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SUMMARY REPORT ON METAL PROCESSING RESEARCH

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WESTINGHOUSE ELECTRIC CORPORATION
ADVANCED ENERGY SYSTEMS DIVISION
PITTSBURGH, PENNSYLVANIA 15236

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AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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This technical report has been reviewed and is approved for publication.

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This report summarizes the findings of research conducted on metal processing over a two ~~(2)~~ year period. The research included the study of the occurrence of the central burst defect in 7075 Al, the effect of hydrogen on the flow stress of Ti6Al-4V and other titanium alloys (CP-Ti, Ti-5Al-2.5Sn) and the design and use of a high sensitivity load cell. Information derived from this and past research was applied to the processing of numerous metal working operations of other alloys.

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FOREWORD

This report was prepared by the Westinghouse Electric Corporation, Advanced Energy Systems Division, Pittsburgh, Pennsylvania, under USAF Contract No. F33615-78-C-5003. The project was initiated under Project No. 7351, "Metallic Materials", Task No. 735108, "Processing of Metals", and was administered under the direction of the Wright Aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio with Mr. A. M. Adair (AFWAL/MLLM) as Project Engineer.

The work described in this report was carried out between 16 February 1978 and 30 April 1980. Forging, Extrusion, Heat Treatments and other technical support was provided by the following Westinghouse personnel:

T. M. Brown
J. O. Brown
T. E. Jones
M. M. Myers
S. E. Nash
R. A. Sweeney

Typing and editing support was provided by J. F. Hickman.

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SECTION I

INTRODUCTION

The experimental effort described in this investigation is a continuation of work[1-19] carried out at the Materials Laboratory, Wright-Patterson Air Force Base, Ohio to advance the science and technology of metal deformation processing for aerospace applications. The principal objective of this effort was to determine quantitative metalworking process design procedures for the selection and control of processing parameters for production of metallic shapes with desired external geometry and internal microstructure. The program consisted of three tasks which were conducted concurrently at the Experimental Metals Processing Laboratory at the Wright-Patterson Air Force Base. The first task entailed process design studies for metalworking operations, for the exploitation of processing advantages of alpha or near alpha titanium alloys containing hydrogen. The work performed under this task concentrated primarily on the effects of hydrogen on the flow stress of Ti-6Al-4V. Some additional work was also performed on Ti-5Al-2.5Sn and commercially pure Ti-30A.

The second task entailed the effects of metalworking variables on the generation of defects during processing. The work conducted under this task was performed on extrusion of 7075 Al.

The third task entailed the utilization of optimum processing parameters and techniques, both those developed in the first two tasks and those gained from previous experience, to process experimental materials from alloy development programs of the Air Force and other government agencies. The aim of this task was to obtain the maximum yield of sound material for metallurgical evaluation. The work performed under the third task included extrusion, forging, rolling, swaging, melting, and heat treatment of experimental alloys. A total of 469 billets and bars were processed for this effort. Tabulated data on the extrusions carried out under this task are included in this report.

The major portion of the research findings have already been presented in detail in the form of Materials Laboratory Technical Reports. Only summaries of these studies are presented in this report, together with brief discussions of work which has not yet been published.

SECTION II

INVESTIGATION OF METAL PROCESSING OPERATIONS

A. Pilot Plant Forging of Hydrogenated Ti-6Al-4V[20]

A pilot plant forging program for hydogenated Ti-6Al-4V is described in this program and was performed on ingot stock which was machined into ring-shaped workpieces. The rings were hydrogenated to obtain hydrogen

content between 0.1 weight percent and 1.2 weight percent. A micro-balance technique was used to determine the hydrogen content. A description of the equipment and procedures for hydrogenation of the material and verification of hydrogen analysis is given[20].

The ring forgings were performed on a hydraulic forge press using isothermal techniques. A temperature range between 922°K (1200°F) and 1144°K (1600°F) and deformation rates of $1.26 \times 10^{-1} ms^{-1}$ (0.3 ipm) and $1.26 \times 10^{-1} ms^{-1}$ (30.0 ipm) were used in the forging evaluation. Two different heats of material were used. Three to six rings were forged at different reductions at each condition of temperature, rate and hydrogen content. Non-hydrogenated rings were also forged at each condition to form a baseline for comparison. Standard techniques were used to analyze the ring forging data.

Results from the program show that a 30 percent reduction in forging loads resulted when material with 0.4 weight percent hydrogen is utilized. At larger hydrogen contents, the deformation loads increase and approximately equaled those of non-hydrogenated material when the hydrogen content is 0.8 weight percent. Deformation loads for the material with 0.4 weight percent hydrogen which are equivalent to those for non-hydrogenated product occur at processing temperatures between 56°K (100°F) and 83°K (150°F) lower. These two effects are illustrated in Fig. 1. The application of these results to hydrided titanium powder and to isothermal forging technology is discussed[20]. Information in this report is also applicable to zirconium and hafnium processing technology. Details of this study are included in AFWAL-TR-80-4026.

B. Experimental Forging of Other Titanium Alloys Containing Hydrogen[23]

The effort described above for titanium alloy Ti-6Al-4V was expanded to include, in somewhat abbreviated form, other titanium alloys (such as commercially pure titanium, Ti-30A and alpha titanium Ti-5Al-2.5Sn). Results from these studies show similar trends with hydrogen content. Load reductions for these alloys are somewhat higher, approximately 50 percent. These results support the previously published Russian Data[21-22]. Details of the work on CP-Ti and Ti-5Al-2.5Sn and other alloys will be published in an Materials Laboratory Technical Report[23].

C. Phenomenological Mechanism for the Occurrence of the Extrusion Central Burst Defect[24]

An investigation of defect occurrence during metalworking was conducted for low ratio extrusion billets of 7075 Al partially extruded in a horizontal extrusion press using a three-inch diameter container. Extrusion conditions were selected such that the central burst defect would occur. A rigid ram stop mechanism was employed to halt the extrusion process abruptly after selected increments of deformation were achieved in each billet. This rigid ram stop mechanism is shown in Fig. 2. Metallographic sections of the partially extruded billets using the rigid ram stop mechanism illustrating the development of the defect are shown in Figs. 3 and 4. Metallographic and Scanning Electron Microscope analyses were used to identify the development of the defect.

The occurrence of the defect was found to be preceded by the development of a tangential velocity discontinuity surface in the deformation zone. Enhanced metal flow in the radial direction on the die exit side of this discontinuity surface caused tensile stresses to develop along the axis of the billet initiating the defect by a tensile overload mechanism. The defect was found to propagate along the discontinuity surface but was halted when continued ram motion caused continued plastic flow along this discontinuity surface to become diffused. The defect development process is illustrated schematically in Fig. 5. Details of the effort are presented in AFML-TR-79-4031[24].

D. High Sensitivity-Low Capacity Load Cell With Overload Protection

A high sensitivity-low capacity load cell was designed and built to satisfy the need for measurement of loads, representing a small fraction of the load capacity of the equipment, that is often encountered in metalworking operations. This situation can result from small workpieces because of limited amounts of experimental materials, prior deformation processing of the ingots or constraints on experimental variables. Measurement of small loads can pose linearity and sensitivity difficulties when using load cells designed to accommodate full press capacity. The load cell design, shown in Fig. 6, has a load measuring capacity of 200,000 lbs and is capable of accommodating full press load (1.1×10^5 lbs) safely.

The load cell was instrumented with strain gages and calibrated up to 200,000 lbs on a certified testing machine. Flow stress-strain curves were determined from the forging loads measured with the cell using the Ring Compression Test[8]. The stress-strain curves are shown in Fig. 7. Details are found in an Materials Laboratory Technical Report in print[25].

A modification to the load cell was accomplished that resulted in an increase in the linearity range of the cell. The modification consisted of a change in the free deformation clearance between the measuring cell and the safety block. This change became necessary due to a misalignment of a 0.004 inch thick ring previously used to adjust the deformation characteristics of the previously used cell. This modification resulted in a drop of the output of the cell to a maximum of about 20% at the lower load range. This means that a maximum uncertainty of $\pm$ 10% is possible on the lower load range used to obtain the flow stress data of Fig. 7.

Changes in the forging method and in the method of data analysis for the Ring Compression Test are currently underway under Contract No. F33615-79-C-5096 and could have a significant impact on the stress-strain data computed from the Ring Compression Test. Corrections to the data in Sections IIA, IIB and IIC will be made as necessary when said data analysis is completed.

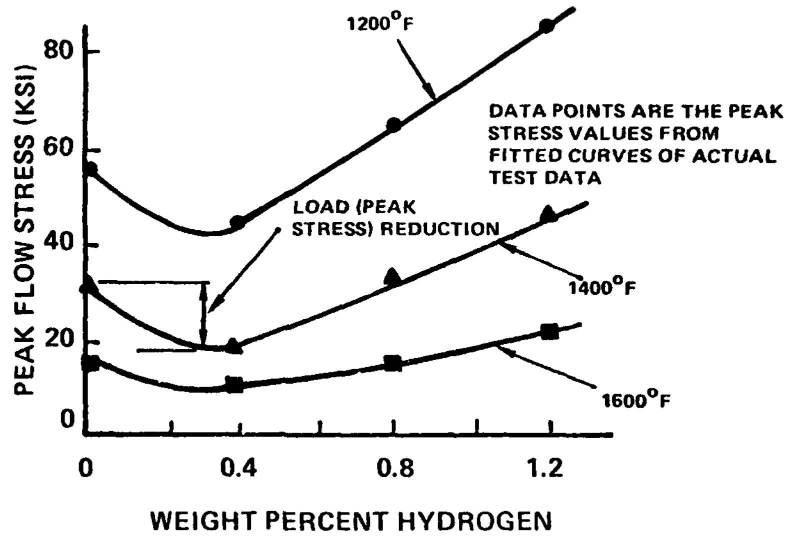
SECTION III

APPLIED METAL PROCESSING

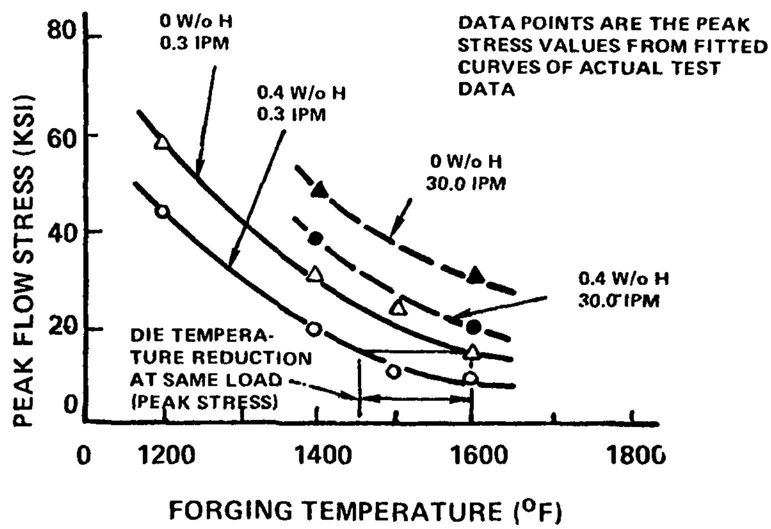
The experience gained during the performance of the experimental programs outlined in Section II, combined with prior expertise and knowledge of metal forming, has been applied to the processing of more than 469 billets and bars of experimental materials related to government alloy development programs. The processing included extrusion, conventional and isothermal forging, rolling, swaging and melting. All types of materials were processed during these studies, ranging from aluminum alloys to tungsten alloys. A variety of starting material forms, cast, powder and wrought conditions were included in the processing operations. A number of heat treatment operations were also performed in these application studies.

A listing of the billets processed by extrusion for these application studies are included in Table 1, together with the deformation pressure for the particular processing conditions and a description of the product quality.

HYDROVAC FORGING



30% REDUCTION IN FORGING LOAD



150°F REDUCTION IN HOT FORMING TEMPERATURES

Fig. 1. Hydrovac forging advantages.

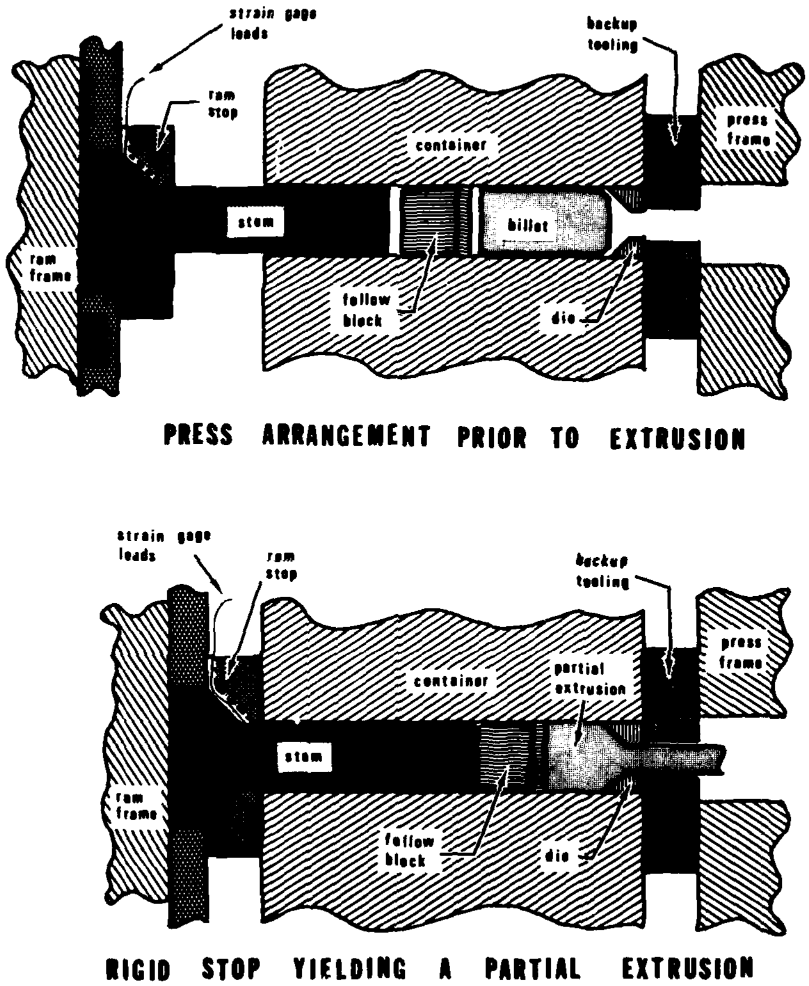


Fig. 2. Illustration of the rigid ram stop used for the partial extrusions.

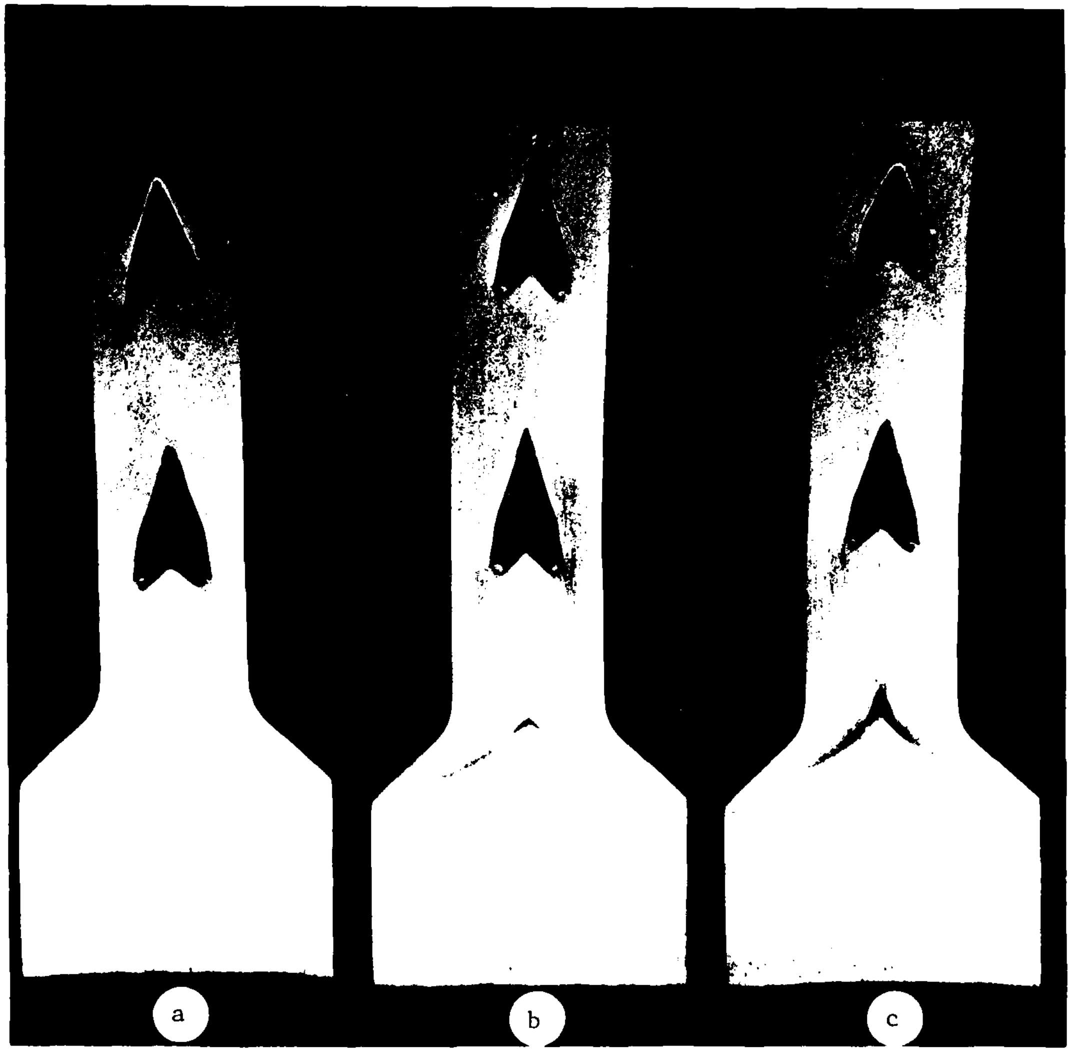


Fig. 3. Macrographs of a sequence of longitudinally sectioned partially extruded billets showing the development, propagation and repetition of the central burst defect. The above sequence shows a) the development of the tangential velocity discontinuity surface, b) the initiation of the burst at the axial center of the billet at the tip of the discontinuity surface and c) the rapid opening of the defect.

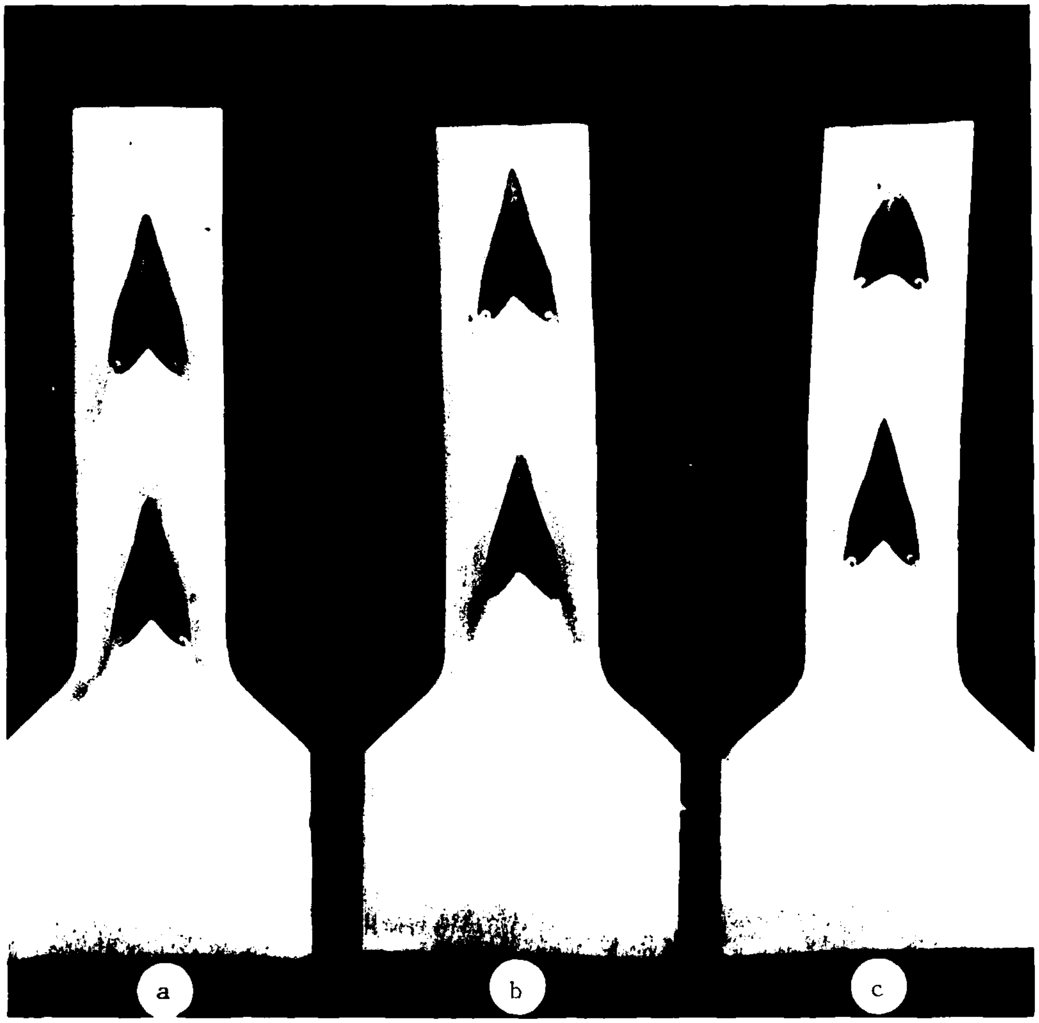
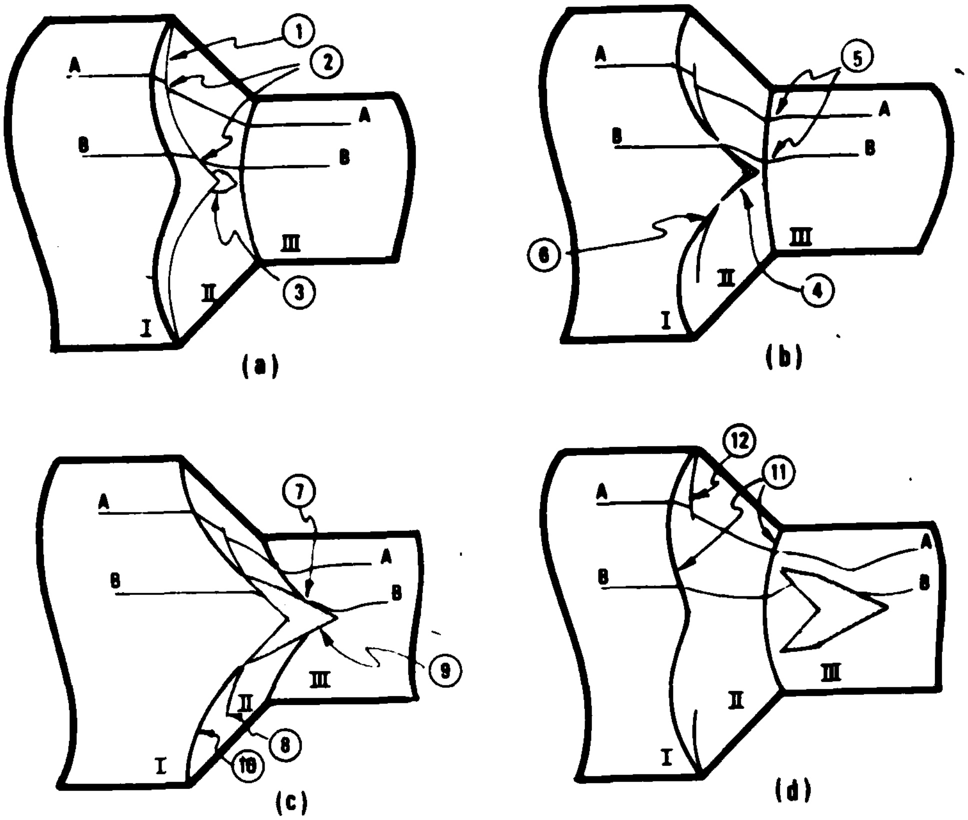


Fig. 4. The above sequence shows a) the fully developed defect exiting the die with metal flow concentrated at the outer shell of the product followed by b) the re-establishment of the metal flow within the die cone and the initiation of a new tangential discontinuity surface beginning at the outer portion of the billet where the initial entry to the die cone occurs and c) the continued development of the discontinuity with concentrated flow in preparation for the next burst.



Region I - Nondeformed Material
Region II - Deformation Zone
Region III - Product Material

Fig. 5. Phenomenological mechanism of the development, propagation and repetition of the central burst defect. a) Development of tangential velocity surfaces (1) occurs with bands of localized flow. Tangential flow along the discontinuity (2) is translated to axial flow toward the die exit and results in a region of enhanced tensile stress (3) at the billet axis. b) Initiation of the central burst defect (4) results from tensile overload. Wavy flow lines (5) develop while the deformation zone volume shrinks by movement of the entrance boundary (6) toward the die exit. c) Discontinuous flow lines develop (7) as the defect propagates along the discontinuity surface but propagation becomes less energetically favorable as the geometric position of the flow surface proceeds through the deformation zone (8). The defect opens rapidly (9) as flow concentrates (10) at the outer flow lines. d) As the defect passes through the die the deformation zone (11) becomes re-established and new tangential velocity discontinuity surfaces (12) begin at the outer surfaces of the billet near the entrance to the die cone.

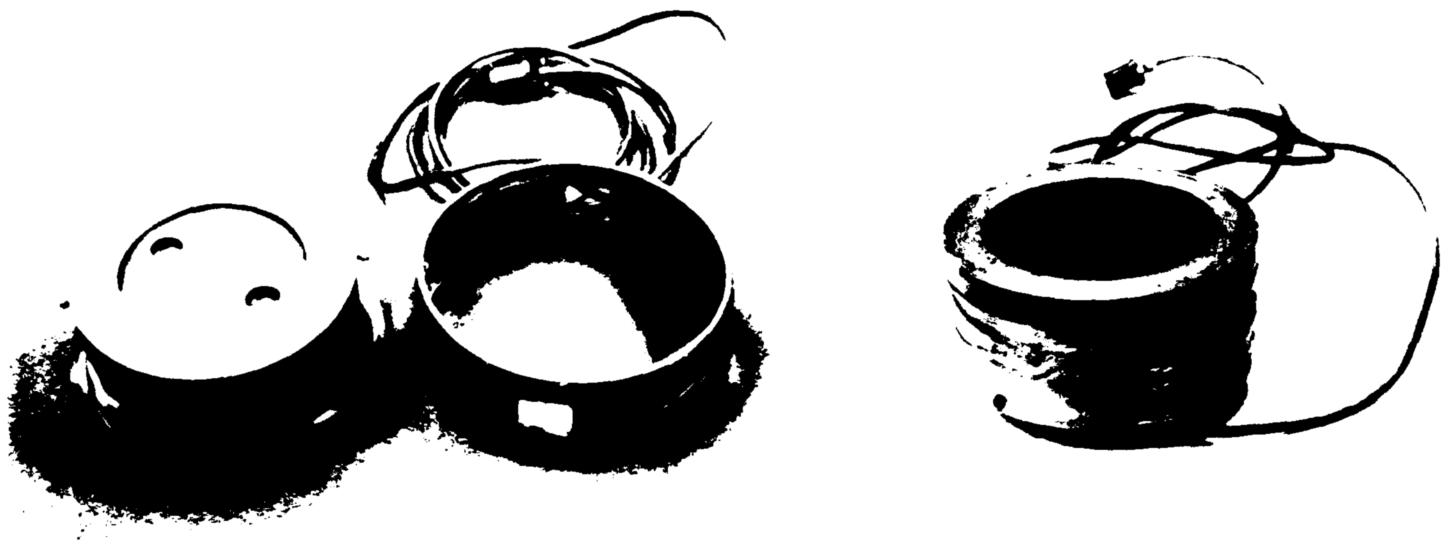


Fig. 6 Photograph of the high sensitivity load cell showing a) the strain gaged sleeve and the solid core overload section (note the solid core overload section is shown upside down) and also showing b) the assembled sections in the operational arrangement.

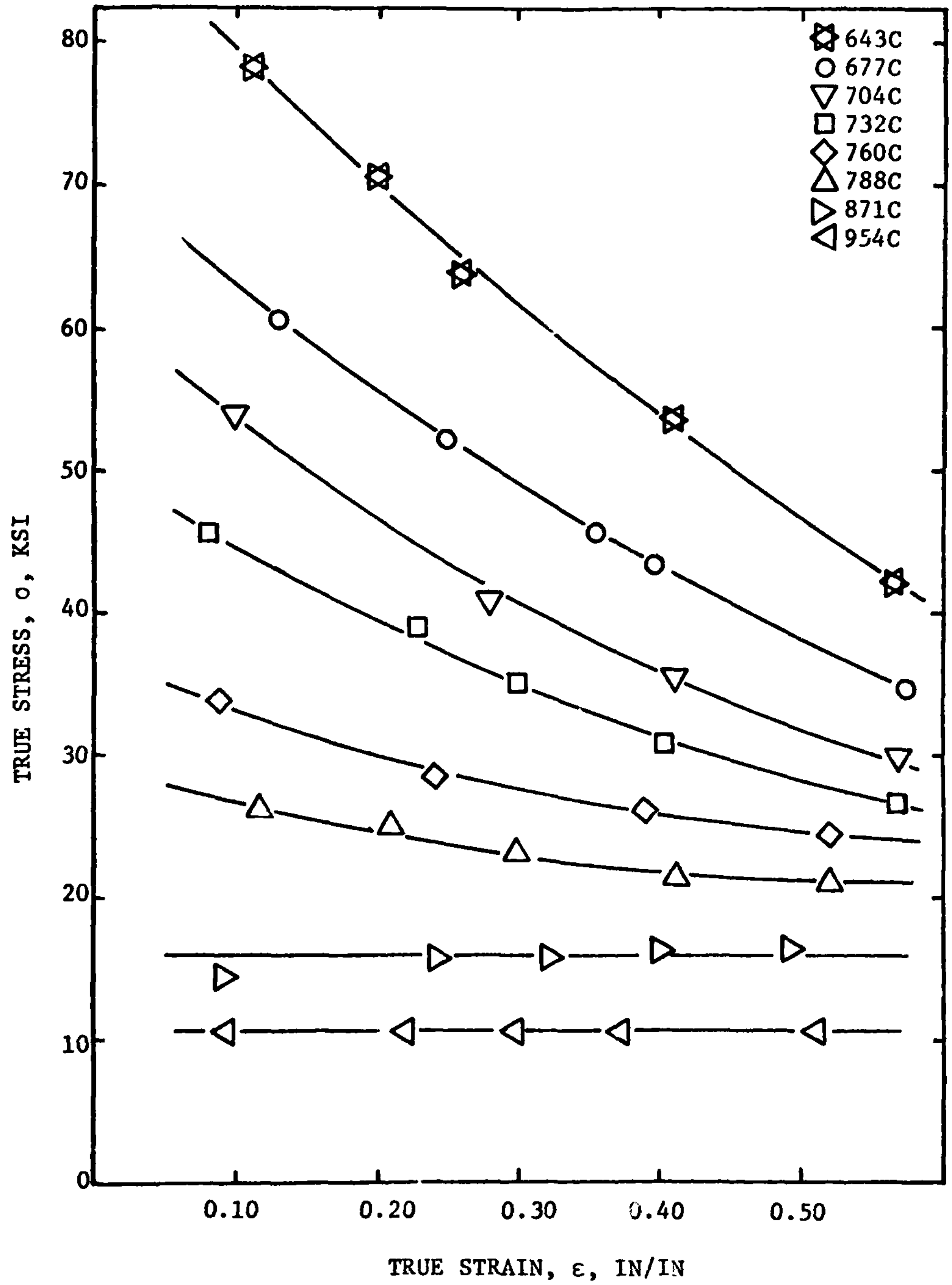


Fig. 7. Flow stress-strain curves for Ti-10V-2Fe-3Al forged isothermally at 3.00 ipm (nominal). Grain Size = 255μm. The forging loads needed for the flow stress calculation using the ring compression test[2-5] were measured using the load cell previously described.

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TABLE 1

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^oF	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7091	Pratt & Whitney	Ni-17Mo-6Al-6Ta	2300	44.6:1	7052	120^o	146	1.2	Good
7092	Pratt & Whitney	Ni-14Mo-7Al-6Ta	2300	44.6:1	7052	120^o	162	1.0	Good
7093	Pratt & Whitney	Ni-14Mo-6Al-9Ta	2300	44.6:1	7052	120^o	162	.9	Good
7094	Pratt & Whitney	Ni-14Mo-5Al-9Ta	2300	44.6:1	7052	120^o	157	1.0	Good
7095	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	44.6:1	7052	120^o	140	---	Good
7096	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	12:1	7052	120^o	113	1.4	Good
7097	Pratt & Whitney	Ni-14Mo-5Al-9Ta	2300	44.6:1	7052	120^o	140	1.2	Good
7098	Pratt & Whitney	Ni-11Mo-7Al-6Ta	2300	44.6:1	7052	120^o	159	1.0	Good
7099	Pratt & Whitney	Ni-11Mo-6Al-9Ta	2300	44.6:1	7052	120^o	146	1.2	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7100	Pratt & Whitney	Ni-14Mo-6Al-6Ta	1600	Blank	Poly	Blank	192	.5	Good
7102	Pratt & Whitney	MARM-200 Mod.	2250	20:1	0010	60°	100	1.2	Good
7103	Pratt & Whitney	MARM-200 Mod.	2250	20:1	0010	60°	97	---	Good
7104	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2250	12:1	0010	120°	109	1.1	Good
7105	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2250	5.95:1	0010	90°	104	1.3	Good
7112	AFWAL/MLLM	713C	2050	7.8:1	0010	90°	181	.8	Fair
7113	AFWAL/MLLM	713C	2050	7.8:1	0010	90°	199	.7	Bad
7128	AFWAL/MLLM	713C	2050	6.45:1	7052	90°	151	1.1	Excellent
7129	AFWAL/MLLM	713C	2050	6.45:1	7052	90°	162	.8	Excellent
7136	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	8:1	7052	60°	122	1.0	Good
7137	Pratt & Whitney	Ni-18Mo-8Al-.04C	2300	44.6:1	7052	120°	148	.8	Good
7138	Pratt & Whitney	Ni-11Mo-7Al-6Ta	2300	44.6:1	7052	120°	170	.9	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7139	Pratt & Whitney	Ni-11Mo-6Al-9Ta	2300	44.6:1	7052	120°	136	.9	Good
7140	Pratt & Whitney	Ni-11Mo-5Al-11.5Ta	2300	44.6:1	7052	120°	150	.9	Good
7141	Pratt & Whitney	Ni-12Mo-6Al-6Ta-7Cr	2300	44.6:1	7052	120°	132	1.0	Good
7142	Pratt & Whitney	Ni-15Mo-7Al-1.6Cb	2300	44.6:1	7052	120°	124	.9	Good
7143	Pratt & Whitney	Ni-15Mo-6Al-3.2Cb	2300	44.6:1	7052	120°	138	.9	Good
7144	Pratt & Whitney	Ni-15Mo-7Al-0.8Ti	2300	44.6:1	7052	120°	159	.8	Good
7145	Pratt & Whitney	Ni-15Mo-6Al-1.6Ti	2300	44.6:1	7052	120°	140	.9	Good
7146	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.04C	2300	44.6:1	7052	120°	151	.9	Good
7147	Pratt & Whitney	Ni-11Mo-6Al-6Ta	2300	44.6:1	7052	120°	146	.9	Good
7148	Pratt & Whitney	Ni-14Mo-7Al-6.1W-.04C	2300	44.6:1	7052	120°	146	.9	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7149	Pratt & Whitney	MIT Steel	1550	20:1	0010	60^o	200	1.1	Good
7164	Pratt & Whitney	Ni-53.4Co-20.12-14.16Cr(+)	1850	Blank	Poly	90^o	200	.5	Good
7165	Pratt & Whitney	Ni-52.87Co-20.02Cr-14.09(+)	1850	Blank	Poly	90^o	200	.5	Good
7166	Pratt & Whitney	Ni-52.58Co-19.91Cr-14.01(+)	1850	Blank	Poly	90^o	200	.5	Good
7167	Pratt & Whitney	Ni-52.29Co-19.80Cr-13.93(+)	1850	Blank	Poly	90^o	200	.5	Good
7168	Pratt & Whitney	Ni-55.7Co-18.51Cr-12.29(+)	1850	Blank	Poly	90^o	201	.5	Good
7169	Pratt & Whitney	Ni-55.24Co-18.35Cr-12.38(+)	1850	Blank	Poly	90^o	200	.5	Good
7170	Pratt & Whitney	Ni-54.90Co-18.23Cr-12.30(+)	1850	Blank	Poly	90^o	200	.5	Good
7171	Pratt & Whitney	Ni-54.55Co-18.12Cr-12.22(+)	1850	Blank	Poly	90^o	201	.5	Good
7172	Pratt & Whitney	Ni-54.34Co-19.26Cr-13.41(+)	1850	Blank	Poly	90^o	201	.5	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7173	Pratt & Whitney	Ni-54.34Co-19.26Cr-13.41(+)	1850	Blank	Poly	90^o	200	.5	Good
7174	Pratt & Whitney	Ni-53.81Co-19.01Cr-13.08(+)	1850	Blank	Poly	90^o	194	.5	Good
7175	Pratt & Whitney	Ni-53.38Co-18.92Cr-13.17(+)	1850	Blank	Poly	90^o	197	.5	Good
7176	Pratt & Whitney	Ni-54.30Co-19.25Cr-13.41(+)	1850	Blank	Poly	90^o	201	.5	Good
7177	Pratt & Whitney	Ni-53.95Co-19.12Cr-13.31(+)	1850	Blank	Poly	90^o	194	.5	Good
7178	Pratt & Whitney	Ni-53.60Co-19.01Cr-13.23(+)	1850	Blank	Poly	90^o	200	.5	Good
7179	Pratt & Whitney	Ni-54.36Co-19.25Cr-13.40(+)	1850	Blank	Poly	90^o	197	.5	Good
7180	Pratt & Whitney	Ni-53.48Co-18.95Cr-13.19(+)	1850	Blank	Poly	90^o	200	.5	Good
7181	Pratt & Whitney	Ni-53.35Co-18.90Cr-13.16(+)	1850	Blank	Poly	90^o	201	.5	Good
7182	Pratt & Whitney	Ni-54.08Cr-19.16Cr-13.35(+)	1850	Blank	Poly	90^o	200	.5	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7183	Pratt & Whitney	Ni-53.26Co-19.05Cr-13.27(+)	1850	Blank	Poly	90°	194	.5	Good
7184	Pratt & Whitney	Ni-53.50Co-18.96Cr-13.20(+)	1850	Blank	Poly	90°	197	.5	Good
7185	Pratt & Whitney	Ni-53.73Co-19.04Cr-13.26(+)	1850	Blank	Poly	90°	196	.5	Good
7186	Pratt & Whitney	Ni-53.42Co-18.93Cr-13.18(+)	1850	Blank	Poly	90°	200	.5	Good
7187	Pratt & Whitney	Ni-53.10Co-18.81Cr-13.10(+)	1850	Blank	Poly	90°	194	.5	Good
7188	Pratt & Whitney	Ni-57.59Co-19.26Cr-10.55(+)	1850	Blank	Poly	90°	200	.5	Good
7189	Pratt & Whitney	Ni-56.39Co-18.85Cr-10.32(+)	1850	Blank	Poly	90°	197	.5	Good
7190	Pratt & Whitney	Ni-55.92Co-18.88Cr-10.27(+)	1850	Blank	Poly	90°	200	.5	Good
7191	Pratt & Whitney	Ni-55.28Co-18.85Cr-10.32(+)	1850	Blank	Poly	90°	193	.5	Good
7192	Pratt & Whitney	Ni-54.96Co-18.73Cr-10.26(+)	1850	Blank	Poly	90°	198	.5	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^oF	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7193	Pratt & Whitney	Ni-54.56Co-18.62Cr-10.20(+)	1850	Blank	Poly	90^o	194	.5	Good
7194	Pratt & Whitney	Ni-61.62Co-12.50Cr-10.30(+)	1850	Blank	Poly	90^o	197	.5	Good
7195	Pratt & Whitney	Ni-61.31Co-10.25Cr-12.41(+)	1850	Blank	Poly	90^o	197	.5	Good
7196	Pratt & Whitney	Ni-57.02Cr-17.5Cr-11.55(+)	1850	Blank	Poly	90^o	194	.5	Good
7197	Pratt & Whitney	Ni-56.64Co-17.33Cr-11.47(+)	1850	Blank	Poly	90^o	194	.5	Good
7198	Pratt & Whitney	Ni-56.26Co-17.22Cr-4.39(+)	1850	Blank	Poly	90^o	194	.5	Good
7199	Pratt & Whitney	Ni-55.32Co-17.32Cr-11.46(+)	1850	Blank	Poly	90^o	197	.5	Good
7201	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	1850	Blank	Poly	90^o	194	.5	Good
7202	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	1850	Blank	Poly	90^o	197	.5	Good
7203	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	1850	Blank	Poly	90^o	197	.5	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7204	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	1850	Blank	Poly	90°	196	.5	Good
7205	Pratt & Whitney	Ni-53.14Co-20.12Cr-14.16(+)	2000	6:1	7052	60°	92	1.3	Good
7206	Pratt & Whitney	Ni-52.87Co-20.02Cr-14.09(+)	2000	6:1	7052	60°	89	1.5	Good
7207	Pratt & Whitney	Ni-52.58Co-19.91Cr-14.01(+)	2000	6:1	7052	60°	92	1.3	Good
7208	Pratt & Whitney	Ni-52.29Co-19.80Cr-13.93(+)	2000	6:1	7052	60°	97	1.2	Good
7209	Pratt & Whitney	Ni-55.7Co-18.51Cr-12.29(+)	2000	6:1	7052	60°	100	1.2	Good
7210	Pratt & Whitney	Ni-55.24Co-18.35Cr-12.38(+)	2000	6:1	7052	60°	92	1.3	Good
7211	Pratt & Whitney	Ni-54.90Co-18.23Cr-12.30(+)	2000	6:1	7052	60°	92	1.2	Good
7212	Pratt & Whitney	Ni-54.55Co-18.12Cr-12.22(+)	2000	6:1	7052	60°	122	1.3	Good
7213	Pratt & Whitney	Ni-54.34Co-19.26Cr-13.41(+)	2000	6:1	7052	90°	92	1.3	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7215	Pratt & Whitney	Ni-54.34Co-19.26Cr-13.41(+)	2000	6.5:1	7052	60°	95	1.8	Good
7216	Pratt & Whitney	Ni-53.81Co-19.01Cr-13.08(+)	2000	6.5:1	7052	90°	113	1.7	Good
7217	Pratt & Whitney	Ni-53.38Co-18.92Cr-13.17(+)	2000	6.5:1	7052	60°	97	1.7	Good
7218	Pratt & Whitney	Ni-54.30Co-19.25Cr-13.41(+)	2000	6.5:1	7052	60°	97	1.7	Good
7219	Pratt & Whitney	Ni-53.95Co-19.12Cr-13.31(+)	2000	6.5:1	7052	60°	89	1.9	Good
7220	Pratt & Whitney	Ni-53.60Co-19.0Cr-13.23(+)	2000	6.5:1	7052	60°	92	1.8	Good
7221	Pratt & Whitney	Ni-54.36Co-19.25Cr-13.40(+)	2000	6.5:1	7052	60°	92	1.8	Good
7222	Pratt & Whitney	Ni-53.48Co-18.95Cr-13.19(+)	2000	6.4:1	7052	60°	92	1.8	Good
7223	Pratt & Whitney	Ni-53.35Co-18.90Cr-13.166(+)	2000	6.4:1	7052	60°	89	1.8	Good
7224	Pratt & Whitney	Ni-54.08Co-19.16Cr-13.35(+)	2000	6.1	7052	60°	95	1.9	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp ^oF	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	Ve_x (ips)	Surface
7225	Pratt & Whitney	Ni-53.76Co-19.05Cr-13.27(+)	2000	6.4:1	7052	60^o	95	1.8	Good
7226	Pratt & Whitney	Ni-53.50Co-18.96Cr-13.20(+)	2000	6.4:1	7052	60^o	101	1.7	Good
7227	Pratt & Whitney	Ni-53.73Co-19.04Cr-13.26(+)	2000	6.4:1	7052	60^o	100	1.8	Good
7228	Pratt & Whitney	Ni-53.42Co-18.93Cr-13.18(+)	2000	6.4:1	7052	60^o	97	1.7	Good
7229	Pratt & Whitney	Ni-53.10Co-18.81Cr-13.10(+)	2000	6:1	7052	60^o	86	1.9	Good
7230	Pratt & Whitney	Ni-51.59Co-19.26Cr-10.55(+)	2000	6:1	7052	60^o	95	1.8	Good
7231	Pratt & Whitney	Ni-56.39Co-18.85Cr-10.32(+)	2000	6:1	7052	60^o	108	1.8	Good
7232	Pratt & Whitney	Ni-55.92Co-18.88Cr-10.27(+)	2000	6:1	7052	60^o	103	1.7	Good
7233	Pratt & Whitney	Ni-55.28Co-18.85Cr-10.32(+)	2000	6:1	7052	60^o	86	1.8	Good
7234	Pratt & Whitney	Ni-54.96Co-18.73Cr-10.26(+)	2000	6:1	7052	60^o	96	1.8	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7235	Pratt & Whitney	Ni-54.65Co-18.62Cr-10.20(+)	2000	6.4:1	7052	60°	93	1.8	Good
7236	Pratt & Whitney	Ni-61.62Co-12.5Cr-10.30(+)	2000	6.4:1	7052	60°	108	1.7	Good
7237	Pratt & Whitney	Ni-61.31Co-10.25Cr-12.41(+)	2000	6.4:1	7052	60°	107	1.7	Good
7238	Pratt & Whitney	Ni-57.02Co-17.5Cr-11.55(+)	2000	6.4:1	7052	60°	100	1.7	Good
7239	Pratt & Whitney	Ni-56.64Co-17.33Cr-11.47(+)	2000	6.4:1	7052	60°	100	1.7	Good
7240	Pratt & Whitney	Ni-56.30Co-17.22Cr-4.39(+)	2000	6.4:1	7052	60°	101	1.7	Good
7241	Pratt & Whitney	Ni-55.32Co-17.32Cr-11.46(+)	2000	6.4:1	7052	60°	95	1.8	Good
7242	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	2000	6.4:1	7052	60°	101	1.7	Good
7243	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	2000	6.4:1	7052	60°	138	1.5	Good
7244	Pratt & Whitney	Ni-Bal-Cr-12.20Co-18.38(+)	2000	6.4:1	7052	60°	108	1.7	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7245	Pratt & Whitney	Ni-Bal-Cr-12. 20Co-18.80(+)	2000	6.4:1	7052	60°	103	1.7	Good
7259	Pratt & Whitney	Ni-14Mo-7Al-6W-.04C	2300	12:1	7740	60°	95	1.7	Good
7260	Pratt & Whitney	Ni-14Mo-7Al-6W-.04C	2300	30:1	7740	60°	126	1.4	Good
7261	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	12:1	7740	60°	103	1.6	Good
7262	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	30:1	7740	60°	124	1.4	Good
7263	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.015Y	2300	30:1	7740	60°	113	1.5	Good
7264	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.015Y	2300	12:1	7740	60°	92	1.7	Good
7270	Wright State U.	713C	2050	5:1	0010	90°	146	1.5	Good
7271	Wright State U.	713C	2050	5:1	0010	90°	154	1.1	Fair
7272	Wright State U.	713C	2050	5:1	0010	90°	151	1.4	Good
7280	Pratt & Whitney	Low C Astro-loy	1925	6.3:1	0010	60°	108	1.5	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7281	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	30:1	7052	60^{o}	119	1.5	Good
7282	Pratt & Whitney	Ni-14Mo-7Al-6W-.04C	2300	8:1	7052	60^{o}	76	1.7	Good
7283	Pratt & Whitney	Ni-14Mo-7Al-6W-.04C	2300	30:1	7052	60^{o}	104	---	---
7284	Pratt & Whitney	Ni-14Mo-6Al-6W	2300	8:1	7052	60^{o}	73	1.8	Good
7285	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	8:1	7052	60^{o}	81	1.7	Good
7286	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.015Y	2300	30:1	7052	60^{o}	105	1.5	Good
7287	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.015Y	2300	8:1	7052	60^{o}	76	1.7	Good
7288	Pratt & Whitney	Low C Astro-loy	1950	30:1	0010	60^{o}	175	.7	Good
7289	Pratt & Whitney	Ni-14Mo-6.5Ta-.02C-5.7Re	2300	30:1	7052	60^{o}	130	1.3	Good
7290	Pratt & Whitney	Ni-14Mo-6.5Ta-6Al-.005B	2300	48:1	7052	120^{o}	162	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^oF	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7291	Pratt & Whitney	Ni-14Mo-6.0Ta-6Al-.05C	2300	34:1	7052	120°	135	1.4	Good
7292	Pratt & Whitney	Ni-14Mo-6W-7Al-.04C-.015Y	2300	34:1	7052	120°	122	1.5	Good
7293	Pratt & Whitney	Ni-14Mo-6W-7Al-.04C-.015Y	2300	20:1	7052	60°	111	1.6	Good
7294	Pratt & Whitney	Ni-14Mo-6W 7Al-.04C-.015Y	2300	43:1	7052	120°	130	1.4	Good
7305	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	30:1	7052	60°	130	1.5	Good
7306	Pratt & Whitney	Ni-14Mo-6Al-6Ta	2300	30:1	7052	60°	132	1.2	Good
7307	Pratt & Whitney	Ni-14Mo-6Al-6W-.04C	2300	30:1	7052	60°	119	1.3	Good
7308	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.015Y	2300	30:1	7052	60°	130	1.3	Good
7309	Pratt & Whitney	Ni-14Mo-6Al-6Ta-.015Y	2300	30:1	7052	60°	135	1.3	Good
7310	Pratt & Whitney	Ni-14Mo-6.8Al-6.1W-.04B-.04Zr	2300	43:1	7052	120°	143	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7311	Pratt & Whitney	Ni-14Mo-7.3Al-6W-.04C-.015Y	2300	43:1	7052	120°	140	1.0	Excellent
7312	Pratt & Whitney	Ni-12.5Mo-6.7 Al-9W-.04C-.015Y	2300	43:1	7052	120°	142	1.1	Excellent
7313	Pratt & Whitney	Ni-14.4Mo-6.3 Al-3.0W-3.0Ta-.04C-.015Y	2300	43:1	7052	120°	144	1.0	Excellent
7314	Pratt & Whitney	Ni-Carpenter Tech. S. S.	1650	10:1	0010	60°	165	.8	Good
7348	Pratt & Whitney	MARM-200	2300	20:1	7052	60°	103	1.3	Good
7349	Pratt & Whitney	MARM-200	2050	20:1	7052	60°	147	.9	Good
7350	Pratt & Whitney	MARM-200	2050	6:1	7052	60°	96	1.2	Good
7353	Pratt & Whitney	VM-595	700	15.6:1	C-300	60°	70	1.1	Excellent
7354	Pratt & Whitney	VM-615	700	15.6:1	C-300	60°	76	1.1	Excellent
7355	Pratt & Whitney	VM-617	700	15.6:1	C-300	60°	72	1.1	Excellent
7356	Pratt & Whitney	VM-595	800	15.6:1	C-300	60°	59	1.2	Excellent
7358	Pratt & Whitney	VM-581	750	15.6:1	C-300	60°	65	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7359	Pratt & Whitney	VM-582	750	15.6:1	C-300	60°	65	1.2	Good
7360	Pratt & Whitney	VM-583	750	15.6:1	C-300	60°	63	1.2	Good
7361	Pratt & Whitney	VM-595	750	15.6:1	C-300	60°	65	1.1	Good
7362	Pratt & Whitney	VM-615	750	15.6:1	C-300	60°	72	1.2	Good
7363	Pratt & Whitney	VM-617	750	15.6:1	C-300	60°	66	1.2	Good
7371	Pratt & Whitney	Ni-6.8Al-14Mo-6.0W-.015Y	2300	8:1	7740	60°	81	1.2	Good
7372	Pratt & Whitney	Ni-5.8Al-14Mo-6.0Ta-.04Zr	2300	30:1	7740	60°	131	1.0	Good
7373	Pratt & Whitney	Ni-6.7Al-12.7Mo-6.0W-.04C-.015Y	2300	30:1	7740	60°	131	1.0	Good
7374	Pratt & Whitney	Ni-6.8Al-14.4Mo-6.1W-.04C-.04Zr	2300	30:1	7740	60°	119	1.1	Good
7375	Pratt & Whitney	Ni-6.8Al-14.4Mo-6.1W-.04B-.04Zr	2300	30:1	7740	60°	124	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7376	Pratt & Whitney	Ni-6.8Al-14Mo-6.1W-.04C-.04Y	2300	30:1	7740	60°	119	1.0	Good
7377	Pratt & Whitney	Ni-6.8Al-14.4Mo-6.1W-.04C-.04HF	2300	30:1	7740	60°	136	.8	Good
7378	Pratt & Whitney	Ni-7.0Al-13.7Mo-6.2W-.04C-.015Y	2300	30:1	7740	60°	127	1.0	Good
7379	Pratt & Whitney	Ni-7.3Al-14.5Mo-6.2W-.04C-.015Y	2300	30:1	7740	60°	127	1.0	Good
7380	Pratt & Whitney	Ni-7.0Al-15.2Mo-6.2W-.04C-.015Y	2300	30:1	7740	60°	122	1.0	Good
7381	Pratt & Whitney	Ni-6.8Al-13.6Mo-6.2W-.04C-.015Y	2300	30:1	7740	60°	116	1.1	Good
7382	Pratt & Whitney	Ni-6.8Al-14.4Mo-6.0W-.015Y	2200	12:1	7740	60°	131	1.0	Good
7383	Sherritt Gordon	Ni-16Cr-5Al-.05Y_2O_3	1832	10:1	Poly	90°	124	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^oF	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7384	Sherritt Gordon	Ni-16Cr-5%Al $0.5Y_2O_3$	1832	16:1	Poly	90^o	151	.8	Good
7385	Sherritt Gordon	Ni-18.5Cr-$1.7Y_2O_3$	1832	20:1	Poly	90^o	150	.8	Good
7386	Sherritt Gordon	Ni-18.5Cr-$1Y_2O_3$	1832	16:1	Poly	90^o	124	1.0	Good
7387	Sherritt Gordon	Ni-16Cr-5Al-$0.5Y_2O_3$	1922	10:1	Poly	90^o	111	1.0	Good
7388	Sherritt Gordon	Ni-16Cr-5Al-$0.5Y_2O_3$	1922	16:1	Poly	90^o	130	1.0	Good
7389	Sherritt Gordon	Ni-18.5Cr-$1Y_2O_3$	1922	20:1	Poly	90^o	138	.9	Good
7390	Sherritt Gordon	Ni-18.5Cr-$1Y_2O_3$	1922	16:1	Poly	90^o	119	1.0	Good
7391	Sherritt Gordon	Ni-16Cr-5Al-$0.5Y_2O_3$	2012	10:1	Poly	90^o	99	1.1	Good
7392	Sherritt Gordon	Ni-16Cr-5Al-$0.5Y_2O_3$	2012	16:1	Poly	90^o	122	1.0	Good
7393	Sherritt Gordon	Ni-18.5Cr-$1Y_2O_3$	2012	20:1	Poly	90^o	117	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7394	Sherritt Gordon	Ni-18.5Cr-1Y_2O_3	2012	16:1	Poly	90°	105	1.0	Good
7397	Pratt & Whitney	Republic Steel	1550	10:1	0010	60°	178	.9	Good
7398	Pratt & Whitney	Republic Steel	1550	10:1	0010	60°	184	1.0	Good
7399	Pratt & Whitney	Republic Steel	1550	10:1	0010	60°	197	.0	Stuck
7400	Pratt & Whitney	Ni-14.4Mo-6.8Al-6W-.04C	2300	8:1	7052	60°	81	1.2	Good
7401	Pratt & Whitney	Ni-14.4Mo-6.8Al-6W-.04C	2300	30:1	7052	60°	134	1.0	Good
7402	Pratt & Whitney	Ni-12.9Mo-6.8Al-6.2W-.04C-.015Y	2300	30:1	7052	60°	127	1.0	Good
7403	Pratt & Whitney	Ni-12.8Mo-5.9Al-6.0Ta-.04C-.015Y	2300	30:1	7052	60°	127	1.0	Good
7404	Pratt & Whitney	Ni-12.9Mo-6.3Al-3.0Ta-3.1W-.04C-.015Y	2300	30:1	7052	60°	124	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7405	Pratt & Whitney	Ni-12.8Mo-6.3Al-3.0Ta-3.1W-.04C-.015Y	2250	30:1	7052	60^o	126	.9	Good
7406	Pratt & Whitney	Ni-14.4Mo-6.3Al-6.1W-.04C-.015Y	2250	30:1	7052	60^o	135	.9	Good
7407	Pratt & Whitney	Ni-13.5Mo-6.5Al-7.6W-.04C-.015Y	2250	30:1	7052	60^o	127	1.0	Good
7408	Pratt & Whitney	Ni-5.8Al-14.3Mo-6Ta-.04Zr	2250	25.37:1	7052	60^o	178	1.4	Stuck
7409	Pratt & Whitney	Ni-6.8Al-14.4Mo-6W-.04C	2250	25.37:1	7052	60^o	151	1.0	Good
7410	Pratt & Whitney	Ni-6.5Al-15.2Mo-6W-.04C-.015Y	2250	25.37:1	7052	60^o	151	1.0	Good
7411	Pratt & Whitney	Ni-6.1Al-13.6Mo-6Ta-.04C-.015Y	2250	25.37:1	7052	60^o	151	.9	Good
7412	Pratt & Whitney	Ni-6.6Al-13.6Mo-6W-.04C.015Y	2200	25.37:1	7052	60^o	157	.8	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7413	Pratt & Whitney	Ni-6.2Al-15.9Mo-6W-.04C-.015Y	2200	25.37:1	7052	60°	157	.9	Good
7414	Pratt & Whitney	Ni-5.5Al-13.3Mo-6Ta-.04C	2200	25.37:1	7052	60°	155	1.0	Good
7415	Pratt & Whitney	Ni-5.4Al-12.7Mo-6Ta-.04C-.015Y	2200	25.37:1	7052	60°	166	.8	Good
7416	Pratt & Whitney	Ni-5.3Al-14.2Mo-6Ta-.04C.015Y	2200	25.37:1	7052	60°	165	.9	Good
7417	Pratt & Whitney	Ni-7.3Al-14.5Mo-6W-.04C-.015Y	2300	25.37:1	7052	60°	123	1.2	Good
7418	Pratt & Whitney	Ni-6.8Al-14.4Mo-6W-.10Y.015Y	2300	25.37:1	7052	60°	130	1.2	Good
7419	Pratt & Whitney	Ni-7Al-14.4Mo-6W-.04C.015Y	2300	20:1	7052	60°	119	1.2	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7420	Pratt & Whitney	Ni-7Al-14. 4Mo-6W-.04C-.015Y	2300	20:1	7052	60°	113	1.1	Good
7421	Pratt & Whitney	Republic Steel Plate Stock	1550	10:1	0010	60°	148	1.0	Good
7422	Pratt & Whitney	Ni-14.5Mo-6W 7Al-.04C	2300	19.83:1	7740	60°	109	1.0	Good
7423	Pratt & Whitney	Ni-14.5Mo-6W 7Al-.04C	2050	19.83:1	7740	60°	111	1.0	Good
7424	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	19.83:1	7740	60°	113	1.0	Good
7425	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	19.83:1	7740	60°	108	1.0	Good
7426	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	19.83:1	7740	60°	124	1.0	Good
7427	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	19.83:1	7740	60°	113	1.0	Good
7428	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	19.83:1	7740	60°	113	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{e_x} (ips)	Surface
7429	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	19.83:1	7740	60^{o}	111	1.0	Good
7451	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	16:1	7740	60^{o}	95	1.1	Good
7452	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	16:1	7740	60^{o}	97	1.0	Good
7453	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	20:1	7740	60^{o}	116	1.0	Good
7454	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	20:1	7740	60^{o}	112	1.1	Good
7455	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	20:1	7740	60^{o}	113	1.1	Good
7456	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	20:1	7740	60^{o}	122	1.0	Good
7457	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	20:1	7740	60^{o}	122	1.1	Good
7458	Pratt & Whitney	Ni-14.5Mo-6W-7Al-.04C	2300	20:1	7740	60^{o}	119	1.1	Good
7475	Pratt & Whitney	Ni-14.5Mo-6W-7Al-0.04C	2250	10.9:1	7052	90^{o}S	113	1.2	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	Pt (ksi)	V_{ex} (ips)	Surface
7476	Pratt & Whitney	Ni-14.5Mo-6W-7Al-0.04C	2250	10.9:1	7052	90^{o}S	119	1.1	Good
7477	Pratt & Whitney	Ni-14.5Mo-6W-7Al-0.04C	2250	10.9:1	7052	90^{o}S	116	1.1	Good
7478	Pratt & Whitney	Ni-14.5Mo-6W-7Al-0.04C	2300	10.9:1	7052	90^{o}S	105	1.2	Good
7479	Pratt & Whitney	Ni-14.5Mo-6W-7Al-0.04C	2300	10.9:1	7052	90^{o}S	105	1.2	Good
7480	Pratt & Whitney	Ni-14.5Mo-6W-7Al-0.04C	2300	10.9:1	7052	90^{o}S	105	1.2	Good
7484	AFWAL/MLLS	713C	2050	10:1	Poly	60^{o}	148	.5	Good
7493	Pratt & Whitney	Ni-14.4Mo-7Al-6W-.04C	2300	16:1	7052	60^{o}	103	1.6	Good
7494	Pratt & Whitney	Ni-14.4Mo-7Al-6W-.04C	2300	16:1	7052	60^{o}	113	1.6	Good
7495	Pratt & Whitney	Ni-14.4Mo-7Al-6W-.04C	2300	16:1	7052	60^{o}	103	1.7	Good
7496	Pratt & Whitney	Ni-14.4Mo-7Al-6W-.04C	2300	16:1	7052	60^{o}	108	1.7	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7501	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	2200	10.2:1	0010	60°	112	1.5	Good
7502	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	2150	10.2:1	0010	60°	127	1.3	Good
7503	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	2100	10.2:1	0010	60°	135	1.1	Good
7504	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	2050	10.2:1	0010	60°	144	1.0	Good
7505	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	1950	10:1	0010	60°	151	1.0	Good
7506	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	1950	10:1	0010	60°	155	.9	Good
7507	Pratt & Whitney	Ni-14.4Mo-6.8Al-6.0W-.04C	1900	10:1	0010	60°	170	1.0	Good
7514	Pratt & Whitney	RSR-185-A	2250	2.5:1	0010	90°R	49	1.9	Good
7515	Pratt & Whitney	RSR-185-B	2150	2.5:1	0010	90°R	78	2.0	Good
7516	Pratt & Whitney	AF2-1DA	1900	8:1	0010	60°	135	1.4	Good
7517	Pratt & Whitney	AF2-1DA	1850	8:1	0010	60°	151	1.3	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. $^{\circ}F$	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7518	Pratt & Whitney	AF2-1DA	1800	8:1	0010	60°	174	1.3	Good
7525	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	122	1.4	Good
7526	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	140	1.2	Good
7527	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	130	1.4	Good
7528	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	120	1.4	Good
7529	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	123	1.4	Good
7530	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	130	1.3	Good
7531	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	20:1	7052	60°	130	1.3	Good
7532	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	124	1.4	Good
7533	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	119	1.4	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7534	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	127	1.4	Good
7535	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	127	1.4	Good
7536	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	124	1.4	Good
7537	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	127	1.4	Good
7538	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	119	1.4	Good
7539	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	126	1.4	Good
7540	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	124	1.4	Good
7541	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	122	1.4	Good
7542	Pratt & Whitney	Ni-14.4Mo-7Al-6.0W-.04C	2250	16:1	7052	60°	113	1.5	Good
7563	Pratt & Whitney	Ni-9.2Cr-8.3Al-9.5W-.04C	2150	12:1	0010	60°	122	1.4	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7564	Pratt & Whitney	Ni-9.2Cr-8.3 Al-9.5W-.03C	2150	12:1	0010	60°	127	1.3	Good
7565	Pratt & Whitney	Ni-9.6Cr-7.7 Al-2Ti-1.7Cb-.21C	2200	12:1	0010	60°	115	1.4	Good
7566	Pratt & Whitney	Ni-9.6Cr-7.7 Al-2Ti-1.7Cb-.21C	2200	12:1	0010	60°	104	1.5	Good
7567	Pratt & Whitney	Ni-9.7Cr-7.7 Al-9Ti-3.1Cb-.19C	2200	12:1	0010	60°	108	1.5	Good
7568	Pratt & Whitney	Ni-9.7Cr-7.7 Al-.9Ti-3.1Cb-.19C	2200	12:1	0010	60°	103	1.5	Good
7593	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60°	113	1.0	Good
7594	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	108	1.1	Good
7595	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	103	1.1	Good
7596	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	˙04	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	Ve_x (ips)	Surface
7597	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	97	1.1	Good
7598	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	100	1.1	Good
7599	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	100	1.1	Good
7600	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	103	1.1	Good
7601	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	92	1.1	Good
7602	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	105	1.1	Good
7603	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	100	1.1	Good
7609	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	95	1.2	Good
7610	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	95	1.1	Good
7611	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	97	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7612	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^{o}	108	1.0	Good
7613	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^{o}	97	1.2	Good
7614	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	119	1.0	Good
7615	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	108	1.0	Good
7616	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	108	1.0	Good
7617	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	108	1.0	Good
7618	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	103	1.0	Good
7619	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	103	1.0	Good
7620	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	113	1.0	Good
7621	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	16:1	7052	60^{o}	100	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7622	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	15.7:1	7052	60°	108	1.1	Good
7623	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	15.7:1	7052	60°	111	1.0	Good
7624	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	15.7:1	7052	60°	103	1.1	Good
7625	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	15.7:1	7052	60°	100	1.1	Good
7626	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	15.7:1	7052	60°	100	1.1	Good
7627	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	15.7:1	7052	60°	108	1.0	Good
7628	AFWAL/MLTM	Ni-8.3Cr-4.9Mo 9.1W-10Ta-6Al 1.9Ti-.004C (50-PPM Oxygen)	2150	19.27:1	7052	60°	116	1.0	Good
7629	AFWAL/MLTM	Ni-13.7W-4.2Ta 9.2Al-.005C	2150	19.27:1	7052	60°	140	.9	Good
7630	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2250	7.4:1	7052	60°	105	1.1	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7631	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	7.4:1	7052	60°	84	1.2	Good
7632	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	105	1.1	Good
7633	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	97	1.1	Good
7634	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	103	1.0	Good
7635	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	92	1.2	Good
7636	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	92	1.2	Good
7637	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	92	1.2	Good
7638	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	92	1.2	Good
7639	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	95	1.2	Good
7640	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60°	113	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7641	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	103	1.0	Good
7642	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	103	1.0	Good
7643	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	97	1.2	Good
7644	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	97	1.1	Good
7645	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	105	1.0	Good
7646	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	100	1.1	Good
7647	Pratt & Whitney	Ni-6.8Al-14.4 Mo-6.1W-.04C	2300	10:1	7052	60^o	108	1.0	Good
7649	Pratt & Whitney	Co-Mod. IN-100	1875	Blank	Poly	90^o	184	1.0	Good
7650	Pratt & Whitney	Co-Mod. IN-100	1875	Blank	Poly	90^o	187	1.0	Good
7651	Pratt & Whitney	Co-Mod. IN-100	1875	Blank	Poly	90^o	186	1.0	Good

Table 1 (Continued)

NICKEL BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7657	Pratt & Whitney	Co-Mod. IN-100	1950	6:1	7052	90°	148	.8	Good
7658	Pratt & Whitney	Co-Mod. IN-100	1950	6:1	7052	90°	140	1.0	Good
7659	Pratt & Whitney	Co-Mod. IN-100	1950	6:1	7052	90°	124	1.0	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7114	AFWAL/MLLM	Ti-25%Al	2200	25.37:1	0010	120°	49	1.5	Good
7115	AFWAL/MLLM	Ti-25%Al	2200	25.37:1	0010	120°	51	1.4	Good
7116	AFWAL/MLLM	Ti-25%Al	2200	25.37:1	0010	120°	50	1.5	Good
7117	AFWAL/MLLM	Ti-25%Al	2200	25.37:1	0010	120°	49	1.5	Good
7118	AFWAL/MLLM	Ti-25%Al-5%Nb	2200	25.37:1	0010	120°	46	1.5	Good
7119	AFWAL/MLLM	Ti-25%Al-5%Nb 1%W	2200	25.37:1	0010	120°	55	1.5	Good
7120	AFWAL/MLLM	Ti-48%Al-2%W	2575	25.3:1	7740	60°	86	1.1	Good
7121	AFWAL/MLLM	Ti-48%Al-2%W	2575	25.3:1	7740	60°	113	1.0	Good
7122	AFWAL/MLLM	Ti-48%Al-2%W	2575	12:1	7740	60°	70	1.1	Good
7123	AFWAL/MLLM	Ti-48%Al-2%W	2575	6:1	7740	60°	57	1.1	Good
7124	AFWAL/MLLM	Ti-34%Al	2575	25.3:1	7740	120°	70	1.1	Good
7125	AFWAL/MLLM	Ti-37%Al	2575	25.3:1	7740	120°	54	1.2	Coiled
7126	AFWAL/MLLM	Ti-48%Al-1%Nb 1.6%W	2575	25.3:1	7740	60°	81	1.2	---
7127	AFWAL/MLLM	Ti-48%Al-2%Nb 1%W	2575	12.1:1	7740	120°	59	1.3	---

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7200	AFWAL/MLLS	Ti-6Al-4V	1850	30:1	0010	90°	65	1.0	Good
7246	Pratt & Whitney	Ti-32.5Al-4.6Nb-.5W	2550	6:1	7740	60°	43	1.9	Good
7247	Pratt & Whitney	Ti-32.5Al-4.6Nb-.5W	2550	6:1	7740	60°	48	1.9	Good
7248	Pratt & Whitney	Ti-32.5Al-4.6Nb-.5W	2550	6.4:1	7740	60°	48	1.9	Good
7249	Pratt & Whitney	Ti-32.5Al 4.6Nb-.5W	2550	6.4:1	7740	60°	50	1.9	Good
7250	Pratt & Whitney	Ti-32.5Al 4.6Nb-.5W	2550	6.4:1	7740	60°	78	1.9	Bad
7252	AFWAL/MLLM	Ti-34%Al	2575	26:1	7740	60°	59	1.9	Good
7253	AFWAL/MLLM	Ti-48%Al-2%Nb-1%W	2575	26:1	7740	60°	92	1.8	Good
7254	AFWAL/MLLM	Ti-48%Al-2%Nb-1%W	2575	25.3:1	7740	120°	116	1.8	Good
7255	AFWAL/MLLM	Ti-48%Al-2%W	2575	25.3:1	7740	120°	86	1.8	Good
7256	AFWAL/MLLM	Ti-48%Al 2%W	2575	25.3:1	7740	120°	86	1.8	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7257	AFWAL/MLLM	Ti-48%Al-2%W	2450	40:1	7740	90^o	124	1.6	Excellent
7258	AFWAL/MLLM	Ti-25%Al-5%Nb	2200	25.3:1	7052	120^o	86	1.8	Good
7304	AFWAL/MLLM	Ti-48%Al-2%W	2400	40:1	7740	90^o	123	1.2	Excellent
7321	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-.01Si	1900	6:1	0010	90^o	46	2.5	Good
7322	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	54	2.4	Good
7323	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	54	2.4	Good
7324	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	58	2.4	Good
7325	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	43	2.4	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7326	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	54	2.4	Good
7327	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	49	2.4	Good
7328	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90^o	54	2.4	Good
7329	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6.4:1	0010	90^o	57	2.4	Good
7330	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6.5:1	0010	90^o	55	2.4	Good
7331	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6.5:1	0010	90^o	65	2.4	Good
7332	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6.4:1	0010	90^o	59	2.5	Good
7333	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6.5:1	0010	90^o	59	2.5	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7334	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6.4:1	0010	90°	49	2.5	Good
7335	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	137	2.1	Good
7336	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	124	2.0	Good
7337	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	146	2.0	Good
7338	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	126	2.0	Good
7339	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo 0.1Si	1675	6.5:1	0010	90°	126	2.0	Good
7340	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	119	2.2	Good
7341	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	138	2.1	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7342	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	151	2.0	Good
7343	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	130	2.1	Good
7344	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	138	2.1	Good
7345	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	140	2.1	Good
7346	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	127	2.2	Good
7347	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6.5:1	0010	90°	135	2.1	Good
7351	AFWAL/MLLM	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1775	6.5:1	0010	90°	77	1.9	Excellent
7395	AFWAL/MLLM	Ti-48%Al-2.2%W	2300	40.97:1	7740	90°	173	.7	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7396	AFWAL/MLLM	Ti-48%Al-2.2%W	2300	25.37:1	7740	90°	165	.8	Good
7430	AFWAL/MLLM	Ti-[illegible]5w/o-Al	2250	14:1	7740	130°R	120	1.2	Good
7431	AFWAL/MLLM	Ti-28.5w/o-Al	2250	14:1	7740	130°R	56	1.1	Good
7432	AFWAL/MLLM	Ti-32.5w/o-Al	2250	14:1	7740	130°R	75	1.1	Good
7433	AFWAL/MLLM	Ti-36w/o-Al	2550	14:1	7740	130°R	69	1.1	Good
7434	AFWAL/MLLM	Ti-25w/o-Al-13w/o-Nb	2550	14:1	7740	130°R	Didn't fit container		
7435	AFWAL/MLLM	Ti-78.5w/o-TiC	2700	10:1	7740	90°	183	---	Stuck
7436	AFWAL/MLLM	Ti-32w/o-Al-9w/o-W	2450	36.29:1	7740	90°	124	.8	Good
7437	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90°	59	2.4	Good
7438	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90°	65	2.4	Good
7439	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90°	59	2.4	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7440	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90°	67	2.3	Good
7460	Wright State U.	Ti-6Al-6V-2Sn	1500	10.9:1	8871	90°	146	1.7	Good
7461	AFWAL/MLLM	TiC-77.6w/o-Ti-22.4w/o	2700	10:1	7740	90°	146	----	Good
7492	AFWAL/MLLM	Ti-6-2-4-6 Ti-6-2-4-2	1675	7.8:1	0010	90°	---	----	Good
7571	Polytechnic	Ti-Cu-3Al-.2Sn	1700	7.6	0010	Strip Chart Recorder Failed			
7572	Polytechnic	Ti-Cu-3Al-.2Sn	1700	7.5	0010	60°	70	2.8	Good
7580	U. of S. CA	Ti-38V-12Mo-5Al-0.7Si	2200	Blank	7052	90°	184	----	Good
7581	U. of S. CA	Ti-38V-12Mo-5Al-0.7Si	2200	Blank	7052	90°	197	.1	Good
7582	U. of S. CA	Ti-38V-12Mo-5Al-0.7Si	2200	20:1	7052	90°	161	1.1	Excellent
7583	U. of S. CA	Ti-38V-12Mo-5Al-0.7Si	2200	20:1	7052	90°	162	1.0	Good
7585	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo	1900	6.8:1	0010	90°	65	2.5	Excellent

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	Ve_x (ips)	Surface
7586	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo	1900	6.8:1	0010	90°	65	2.5	Excellent
7587	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo	1900	6.6:1	0010	90°	68	2.4	Excellent
7588	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo	1900	6.6:1	0010	90°	62	2.4	Excellent
7589	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo	1900	6.6:1	0010	90°	54	2.5	Excellent
7590	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo	1900	6.1:1	0010	90°	58	2.4	Excellent
7648	SRL	Ti-5Al-2.5Sn-5Zr	1600	6:1	Poly	60°	97	1.5	Good
7741	AFWAL/MLLS	SAME AS 7742							
7742	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1900	6:1	0010	90°	59	2.3	Good
7743	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90°	135	1.8	Good
7744	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90°	137	2.0	Good

Table 1 (Continued)

TITANIUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7745	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90^o	132	2.0	Good
7746	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90^o	140	2.0	Good
7747	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90^o	143	1.8	Good
7748	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90^o	140	1.9	Good
7749	AFWAL/MLLS	Ti-6Al-2Sn-4Zr-2Mo-0.1Si	1675	6:1	0010	90^o	154	1.9	Good

Table 1 (Continued)

IRON BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. ^{o}F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7106	Pratt & Whitney	Fe+()-2.6B+Al 2.2Ti-0.6C	1600	7.8:1	0010	90^o	162	.9	Good
7107	Pratt & Whitney	Fe+()-2.6B+Al 2.2Ti-0.6C	1600	7.8:1	0010	90^o	159	1.5	Good
7108	Pratt & Whitney	Fe+()-2.6B+Al 2.2Ti-0.6C	1600	7.8:1	0010	90^o	156	1.4	Good
7109	Pratt & Whitney	Fe+()2.6B+Al 2.2Ti-0.6C	1600	7.8:1	0010	90^o	173	1.0	Good
7110	Pratt & Whitney	Fe+()2.6B+Al- 2.2Ti-0.6C	1600	7.8:1	0010	90^o	167	1.4	Good
7111	Pratt & Whitney	Fe+()2.6B+Al 2.2Ti-0.6C	1600	7.8:1	0010	90^o	170	1.4	Good
7214	Pratt & Whitney	Fe-1Mn-2Mo-.26C	1550	10:1	7052	60^o	178	1.0	Good
7364	AFWAL/MLLM	Fe-80%-Al-20%	1500	5.1:1	8871	60^o	108	1.5	Good
7365	AFWAL/MLLM	Fe-75%-Al-25%	1500	5.1:1	8871	60^o	97	1.5	Good
7366	AFWAL/MLLM	Fe-72%-Al-28%	1500	5.1:1	8871	60^o	104	1.5	Good
7367	AFWAL/MLLM	Fe-68%-Al-32%	1500	5.1:1	8871	60^o	97	1.5	Good

Table 1 (Continued)

IRON BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7368	AFWAL/MLLM	Fe-64%-Al-36%	1500	5.1:1	8871	60°	100	1.5	Good
7369	AFWAL/MLLM	Fe-58%-Al-42%	1500	5.1:1	8871	60°	97	1.5	Good
7370	AFWAL/MLLM	Fe-50%-Al-50%	1500	5.1:1	8871	60°	81	1.2	Good
7463	Pratt & Whitney	Fe-0.95C-9.0 Cr-2.0Mo-1.0V 0.15Si-0.20Mn	1650	15.5:1	0010	60°	186	.7	Good
7464	Pratt & Whitney	Fe-0.80C-4.0 Cr-2.0Mo-1.0V 0.15Si-0.20Mn	1650	15.5:1	0010	60°	181	.8	Good
7465	Pratt & Whitney	Fe-0.80C-4.10 Cr-2.25Mo-1.0V 0.15Si-0.20Mn	1650	15.5:1	0010	60°	181	.8	Good
7469	Pratt & Whitney	Fe-0.81C-4.0 Cr-4.25Mo-1.0V 0.15Si-0.25Mn	1750	15.5:1	0010	60°	181	.8	Good
7470	Pratt & Whitney	Fe-1.15C-14.75 Cr-4.0Mo-1.2V-0.30Si-0.45Mn	1750	15.5:1	0010	60°	176	.7	Good
7471	Pratt & Whitney	Fe-0.80C-4.0 Cr-2.0Mo-1.0V 0.15Si-0.20Mn	1750	15.5:1	0010	60°	167	.8	Good

Table 1 (Continued)

IRON BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7472	Pratt & Whitney	Fe-0.95C-9.0 Cr-2.0Mo-1.0V 0.15Si-0.20Mn	1750	15.5:1	0010	60°	173	.7	Good
7519	AFWAL/MLLM	Fe-32Al	1800	10:1	Poly	90°	97	1.8	Good
7520	AFWAL/MLLM	Fe-15.82Al	1800	10:1	Poly	90°	105	1.3	Good
7522	AFWAL/MLLM	Fe 3Al	1740	16:1	Poly	60°	116	1.7	Good
7608	AFWAL/MLLM	Fe_3Al	1740	16:1	Poly	90°	126	1.1	Good

Table 1 (Continued)

ALUMINUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P_t (ksi)	V_{ex} (ips)	Surface
7352	Pratt & Whitney	7075Al	700	15.6:1	C-300	60°	73	1.1	Excellent
7352	Pratt & Whitney	7075Al	750	15.6:1	C-300	60°	58	1.2	Good
7466		Al-8.4Zn-2.5 Mg-1.0Cu-3.2Co	700	15.5:1	C-300	60°	76	.4	Excellent
7467	Pratt & Whitney	Al-9.8Zn-2.5 Mg-1.0Cu-.08Co	700	15.5:1	C-300	60°	70	1.0	Excellent
7468	Pratt & Whitney	Al-9.8Zn-2.5 Mg-1.0Cu-2.4Co	700	15.5:1	C-300	60°	62	.4	Excellent
7550	Pratt & Whitney	Al-9.8Zn-2.5 Mg-1Cu-.8C	650	12:1	C-300	60°	84	1.0	Good
7551	Pratt & Whitney	Al-5.6Zn-2.5 Mg-1Cu-1.6Co	650	12:1	C-300	60°	70	1.2	Good
7552	Pratt & Whitney	Al-7.0Zn-2.5 Mg-1Cu-3.2Co	650	12:1	C-300	60°	78	1.1	Good
7553	Pratt & Whitney	Al-5.6Zn-2.5 Mg-1Cu-.8C	700	12:1	C-300	60°	70	1.1	Good
7554	Pratt & Whitney	Al-5.6Zn-2.5 Mg-1Cu-1.6Co	700	12:1	C-300	60°	97	1.2	Good
7555	Pratt & Whitney	Al-5.6Zn-2.5Mg-1Cu-3.2Co	700	12:1	C-300	60°	103	1.2	Good

Table I (continued)

ALUMINUM BASE

EXTRUSION PARAMETERS FOR MAXIMUM YIELD APPLICATIONS

Extrusion Number	Agency	Alloy	Temp. °F	Red. Ratio	Billet Lube	Die Angle	P (ksi)	Vel. (ips)	Surface
7556	Pratt & Whitney	Al-7.0Zn-2.5 Mg-1Cu-3.2Co	700	12:1	C-300	60°	76	1.2	Good
7557	Pratt & Whitney	Al-2.0Zn-2.5 Mg-1Cu-.8C	700	12:1	C-300	60°	68	1.2	Good
7558	Pratt & Whitney	Al-8.4Zn-3.6 Mg-1Cu-.8Co	700	12:1	C-300	60°	88	1.2	Good
7577	AFWAL/MLLS	MA-87Al	970	Blank	C-300	---	54	.4	Good
7578	AFWAL/MLLS	MA-87Al	970	Blank	C-300	---	54	.4	Good
7591	AFWAL/MLLS	MA-87Al	750	20:1	C-300	90°	78	1.0	Good
7592	AFWAL/MLLS	MA-87Al	750	20:1	C-300	90°	86	1.0	Good
7604	AFWAL/MLLN	MA-87-Al	970	Blank	C-300	Flat	---	---	Good
7605	AFWAL/MLLN	MA-87-Al	970	Blank	C-300	Flat	---	---	Good
7606	AFWAL/MLLN	MA-87-Al	970	Blank	C-300	Flat	----	---	Good
7607	AFWAL/MLLN	MA-87Al	970	Blank	C-300	Flat	---	---	Good
7652	AFWAL/MLLS	Al-4Mg-(4-7)	750	20:1	C-300	90°	107	1.0	Excellent
7653	AFWAL/MLLS	Al-4Mg-(4-7)	750	20:1	C-300	90°	109	1.0	Excellent

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